NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

PURPOSE

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. The practice applies to all types of structures, including a combination of earth embankments and spillways, either full-flow or detention-type structures. This practice also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel.

CRITERIA

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilize upstream head cutting.

General criteria. Earth embankment and auxiliary (earth) spillways of structures for which criteria are not provided under the standard for PONDS (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to safely pass the total capacity flow indicated in Tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative coverings such as gravel or other mulches may be used.

Embankment dams. Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 ft in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 ft or less shall meet or exceed the requirements specified for PONDS (378).

The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway (earth spillway) crest and the lowest point in the cross section along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

Table 1. - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet at the crest elevation of the auxiliary spillway.

Maximum drainage area for indicated rainfall[1]			Effective height	Frequency of minimum design, 24-hour
0-3 in.	3 - 5 in.	5+ in.	of dam	duration storm
----------------acres------------------			*ft*	*yr*
200	100	50	35 or less	2
400	200	100	20 or less	2
400	200	100	20 - 35	5
600	400	200	20 or less	5

[1]In a 5-year frequency, 24-hour duration storm

Pond size dams. If spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of detention storage, or as shown in the Emergency and Principal Spillway Proportioning Guide, found in Chapter 2 of the Engineering Field Handbook.

If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre-ft, the Emergency and Principal Spillway Proportioning Guide must be used as the minimum design storm.

Grade stabilization structures with a settled fill height of less than 15 ft and 10-year frequency, 24-hour storm runoff less than 10 acre-ft, shall be designed to control the 10-year frequency storm without overtopping. The principal spillway, regardless of size, may be considered in design; and an auxiliary spillway is not required if the combination of storage and principal spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for WATER AND SEDIMENT CONTROL BASINS (638) rather than the requirements for PONDS (378).

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Handbook for Conservation Practices, the National Engineering Handbook, and other applicable NRCS/SCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure safe reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 4 ft or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Table 2. – Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall[1]			Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 – 3 in.	3 – 5 in.	5+ in.		Principal spillway capacity	Total capacity[2]
----acres----			*ft*	*yr*	*yr*
1,200	450	250	5 or less	5	10
2,200	900	500	10 or less	10	25
All other				25	100

[1]In a 5-year frequency, 24-hour duration storm.
[2]Including both principal and auxiliary spillway.

Table 3. – Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop-drainage structure.

Maximum drainage area for indicated rainfall*			Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 – 3 in.	3 – 5 in.	5+ in.		Receiving channel depth	Total capacity
----acres----			*ft*	*ft*	*yr*
1,200	450	250	0 – 5	0 – 10	5
1,200	450	250	5 – 10	10 – 20	10
2,200	900	500	0 – 10	0 – 20	25
All other					50

*In a 5-year frequency, 24-hour duration storm.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum emergency auxiliary spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway and/or the top of the embankment. Provision must be made for safe reentry of bypassed flow as necessary.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions

CONSIDERATIONS

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources.

Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat.

Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

Special consideration should be given to maintaining or improving habitat for fish and wildlife where applicable.

The earth embankment structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Consider protective guardrails, warning signs, fences, or lifesaving equipment be added as needed.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for constructing and vegetating this practice to achieve its intended purpose.

Preparation of construction drawings and specifications will follow procedures in the Engineering Field Handbook, Chapter 5, "Preparation of Engineering Plans"

Construction and material specifications used for grade stabilization structures will be either Nebraska PL-46 specifications or the "NE" series specifications found in Appendix 1 of the Engineering Field Handbook.

The specifications for revegetating the embankment and auxiliary (earth) spillway areas shall be developed in accordance with the requirements for "CRITICAL AREA PLANTING" and "MULCHING" NRCS Standards 342 and 484, respectfully.

OPERATION AND MAINTENANCE

A comprehensive operation and maintenance plan, carried out by the owner, will enhance the useful life of the grade stabilization structure. The owner or other responsible persons must be advised of their responsibilities and be counseled as to timing of maintenance inspections and methods of performing maintenance.

See pages M-410-1 and 2 for an example Operation & Maintenance (O & M) plan. For most grade stabilization structures, this example will suffice for the O & M plan. When necessary, it can be modified to fit individual site conditions.

REFERENCES

NEBRASKA FIELD OFFICE TECHNICAL GUIDE (FOTG), SECTION IV, PRACTICE STANDARDS & SPECIFICATIONS

342 Critical Area Treatment

378 Ponds

399 Fishpond Management

430 Pipeline, irrigation

516 Pipeline, livestock

ENGINEERING FIELD HANDBOOK (including Nebraska supplements)

EFH Appendix 1, Nebraska Construction Specifications

EFH Appendix 2, Nebraska Standard Drawings

EFH Chapter 2, Hydrology,including the Emergency and Principal Spillway Proportioning Guide

EFH Chapter 3, Hydraulics

EFH Chapter 4, Elementary Soils Engineering

EFH Chapter 5, Preparation of Engineering Plans

EFH Chapter 6, Structures

EFH Chapter 7, Grassed Waterways & Outlets

EFH Chapter 11, Ponds and Reservoirs

EFH Chapter 13, Wetland Restoration

EFH Chapter 17, Construction & Construction Materials

NATIONAL ENGINEERING HANDBOOK

SECTION 3, Sedimentation (Chapter 3, Erosion), (Chapter 6, Sources, Yields, Delivery Ratios), (Chapter 8, Storage Design Criteria)

SECTION 8, Engineering Geology (Chapter 5, Classification of Structure Sites)

TECHNICAL RELEASES

TR-56, Wave Protection For Earth Dam Embankment

TR-69, Riprap For Slope Protection Against Wave Action

TR-77, Design & Installation of Flexible Conduits

NEBRASKA PLANNING PROCEDURES HANDBOOK

SECTION NE607-37, Exhibit NE 66, Form NE-ENG-75 & 76, Layout and Design of a Dry Hydrant

Nebraska PL-46 Construction and Material Specifications

Nebraska NE-Construction Specifications

NEBRASKA GUIDES

Guide to Nebraska Wave Protection Criteria (Design Section)

NEBRASKA ENGINEERING COMPUTER PROGRAM HANDBOOK

User Manuals & Other Information About Computer Programs Used For Design Of Engineering Practices In Nebraska